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Self-directed practice scheduling is equivalent to instructor guided practice when learning a complex surgical skill

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Abstract

The purpose of this study was to look for equivalency between Self-directed (SD) and guided learning of a relatively complex surgical technique. Residents learned three Z-plasty repairs, were given a pre-test and after an hour of practice, a post-test. Fifteen surgical residents were randomly assigned into a SD group (choose practice order) or a Control group (prescribed a practice order yoked to a subject in the SD group). No learning advantage of guided practice over SD practice was found ($p < .05$). Our findings suggest that SD practice schedules may be in fact suitable for learning complex technical skills.

Keywords: Medical education; skill learning; surgery.

1. Introduction

Surgical education is currently undergoing a paradigm shift with respect to the training of surgical technical skills. Recent modifications including the enforcement of shorter workweeks for residents (Reznick & MacRae, 2006) and an emphasis on maintaining high turnover in the operating room (Hamstra, Dubrowski, & Backstein, 2006) have led to severe reductions in training opportunities for new residents (Aggarwal & Darzi, 2006). Moreover, the complexity of patient cases has steadily increased meaning faculty must limit trainees' hands-on opportunities due to medico-legal concerns (Reznick & MacRae, 2006). Thus, medical educators must continuously search for more efficient and effective ways to teach technical clinical skills to medical students and residents as an integral part of professional development and education programs.

Sheer volume of exposure, rather than specifically designed curricula, is the hallmark of current surgical training (Haluck & Krummel, 2000). In newly proposed models of surgical education, basic surgical skills are learned and practiced on models within a classroom, with the aim of better preparing junior trainees for the real operating room

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experience (Scallon, Fairholm, Cochrane, & Taylor, 1992; Heppell, Beauchamp, & Chollet, 1995). In these classrooms an emerging trend is the use of self-directed learning modules (e.g., via online videos), which also requires some independence on the part of the learner, however, it is not clear whether these teaching techniques are effective. Self-directed learning is of particular importance in the field of surgical education due to the limited faculty/staff availability and the time allotted to teach residents the technical surgical skills. If educators want to do one thing to facilitate motor learning, they should provide opportunities for practice. There is a large body of literature that shows that expert performers acquire and maintain their superior performance by extended deliberate practice (Ericsson, Krampe, & Tesch-Römer, 1993; Ericsson & Charness, 1994). There is also an economical aspect that must be considered since the use of surgical educators can be costly. If self directed learning can be shown to be an effective tool then there are potential cost savings.

It is important to note that deliberate practice is necessary, rather than "enforced" practice. Jowett, LeBlanc, Xeroulis, MacRae, & Dubrowski (2007) conducted a study in which medical students were learning a one handed knot tying skill, and they were asked to report when they felt they had attained proficiency and could stop practicing. One half of the students in this study were required to continue practicing even after they felt they did not need this additional practice. Results showed that this additional practice had no effect on how well the skill was retained. Thus, as educators, the challenge is to provide an environment where trainees feel motivated to practice. Self-directed practice might be one means to achieving this goal.

The instructor often dictates the order of practiced tasks or the duration of practice. Thus, the instructor is in control of the training session, and the trainee remains quite passive. However, there is evidence accumulating that motor learning can be facilitated if the learner is able to self-direct their training experience. For example, it has been shown that learner selected frequency of feedback showed learning advantages over feedback schedules controlled by the instructor for both timing and throwing tasks in a laboratory environment (Chiviacowsky & Wulf, 2002; Chen, Hendrick, & Lidor, 2002; Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997). As well, when learners were able to access video instruction as required when learning a basketball jump shot they showed superior learning over an imposed presentation of video instruction (Wulf, Raupach, & Pfeiffer, 2005). These effects are not simply frequency of feedback effects (Park, Shea, & Wright, 2000), but speak to a learning environment that is tailored to the specific informational needs of the individual learner.

One motor learning concept that should be considered is self-regulated learning (SRL). The effectiveness of self-regulated or self-controlled learning environments has been reported in the motor learning literature. Wulf and colleagues (Chiviacowsky & Wulf, 2002; Wulf et al., 2005) have conducted a number of studies investigating self-controlled learning and its mechanism. In general, their studies involve comparing a self-control group to yoked counterparts. The self-control group is permitted to request information (i.e., ask for feedback whenever they need it) or access learning tools (i.e., use physical aids in a balance task or use video instruction) whenever they desire. Members of the yoked group are then matched to a self-control participant and receive feedback at the exact same time during their personal experimental session. Despite the identical practice schedules, self-controlled learners perform better on retention tests than those experiencing an externally controlled (yoked) practice experience (Chiviacowsky & Wulf, 2002). Although many concepts have been forwarded, Wulf et al. (2005) suggest that the benefits of self-controlled practice may arise from participants' increased motivation and more active involvement in the learning process, or from the consistency of the practice schedule with each learner's needs. In addition Chiviacowsky and Wulf (2002) theorize that self-control participants may engage in spontaneous error estimation during practice. Error estimations are assumed to benefit learning, as this encourages learners to focus on their intrinsic feedback and promotes independence from external feedback sources. Thus, it is hypothesized that self-directed learning and practice will be as good as instructor guided practice.

1.1. Purpose

The purpose of this study was to look for equivalency between self-directed learning and instructor guided learning when learning the skill of Z-plasty, a plastic surgery technique used to improve the functional and cosmetic appearance of scars.

2. Methods

2.1. Participants

Fifteen first year surgical residents (6 females, 9 males) from the University of Toronto were recruited to participate in this study. The research was approved by the University of Toronto, and the Mount Sinai Hospital Research Ethics Boards and all participants signed an informed consent.

2.2. Apparatus and Procedure

The Z-plasty technique involves the incision of two lines of equal length at both ends of a linear scar. This incision will create two triangular flaps with the desired angle from the scar. The two flaps are then transposed, changing the direction and the length of the original scar. Sutures are then used to hold the flaps in place. An improper Z-plasty technique can lead to wound complications. Each participant viewed an instructional video of an expert demonstration of three types of Z-plasty techniques: a 30°, 45° and a 60° repair. See Figure 1 for a schematic of the three Z-plasty techniques.

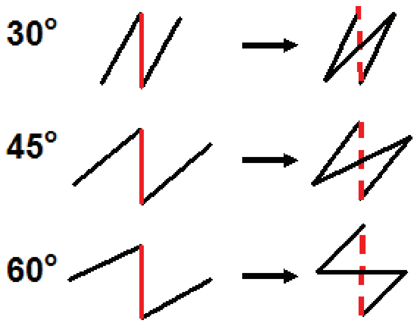

Figure 1. The three types of Z-plasty techniques learned by participants; a 30°, 45° and a 60° repair

All participants performed a pre-test, consisting of one trial of a 45° repair on a synthetic model without any feedback or access to the instructional video. Each participant was then randomly assigned to one of two practice groups (Self-directed = 7 participants; Control = 8 participants). Participants in the Self-directed group were able to choose to practice any of the three types of repairs in any order within the given one hour practice. Participants in the Control group performed exactly the same practice schedule as the Self-directed group, however, instead of this schedule being chosen by them, it was prescribed to them (yoked to a subject in the Self-directed group). During practice all participants were free to review the instructional video as frequently as they wished. Following the practice session, the participants were then re-evaluated on a post-test that was exactly like the pre-test.

2.3. Analyses

The performance of the pre-test and post-test was videotaped to be assessed later by an expert blinded to the experimental condition or group using several validated measures: a) global rating scale b) checklist and c) final product analysis. Total performance time was also obtained from these blinded videos. Previous studies have shown the checklist to be realiable across multiple reviewers ($r > 0.8$) (Brydges, Carnahan, Safir, & Dubrowski, 2009).

Difference scores were taken between the pre and post test scores and these improvement scores were analysed in separate two group one-way analyses of variance (ANOVAs). Significant ANOVA effects were further analyzed using the Tukey HSD Methods for post-hoc comparison of means. For the expert based ratings assessments were based on the expert's viewing of the 45° repair during the pre and post tests.

3. Results

3.1. Performance Time

The analysis of performance time showed an improvement in time to completion from pre-test to post-test for both groups. Means and standard deviations are presented in Figure 2.

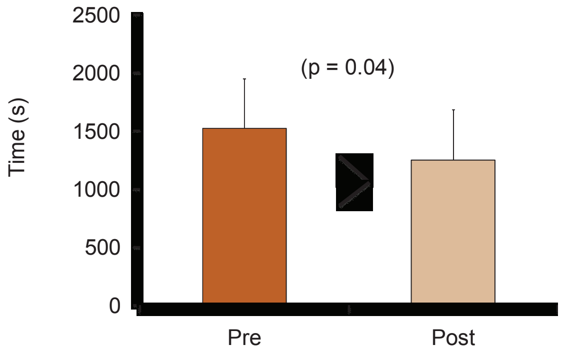

Figure 2. The difference scores for both groups pre and post for the analysis of performance time

3.2. Expert Based Ratings

The analysis of the checklist and global rating scores showed an improvement from pre-test to post-test for both groups. Means and standard deviations are presented in Figure 3. The analysis of the checklist and global rating scores between the two groups as seen in Figure 4, however, did not show any significant differences. There was no learning advantage of guided practice over Self-directed practice.

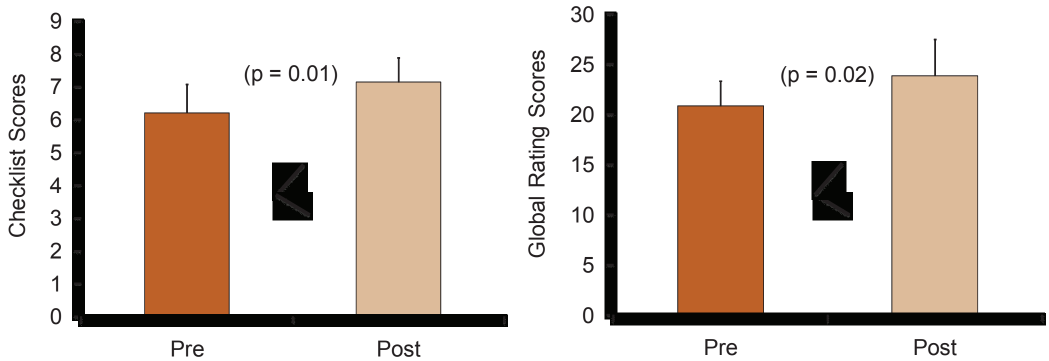

Figure 3. The difference scores for both groups pre and post for the expert based analysis of checklist and global rating

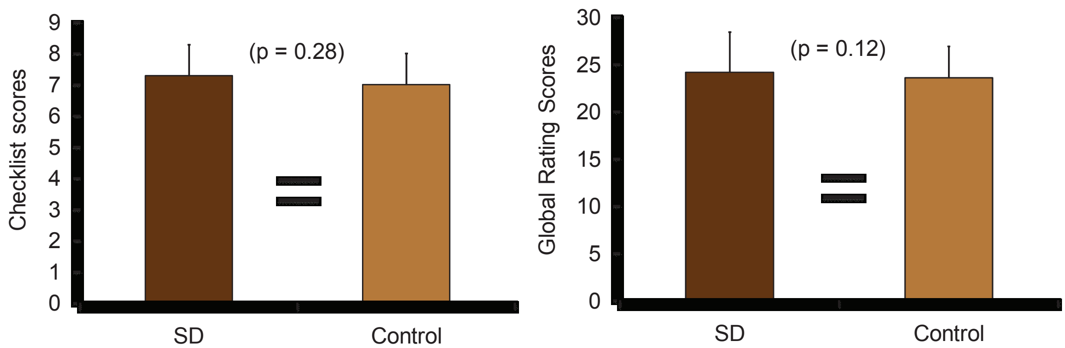

Figure 4. The difference scores for both groups for the expert based analysis of checklist and global rating

4. Discussion

The equivalency seen in the checklist and global rating scores between the Self-directed group and the Control group was an expected outcome since it is consistent with the literature on self-regulated learning. The increased autonomy that occurs with Self-directing practice schedules is likely to allow the participant to tailor the learning experience to his/her specific needs and may also result in increased motivation (Wulf et al., 2005). This increased motivation may lead to increased deliberate practice and the associated benefits.

In the continuous search for the conditions needed to provide an optimal learning environment it is important to consider factors such as the expertise level of your learners and the complexity of the task. Thus, the generalizability of the results from this study is limited to the skill being manipulated and the population that was tested.

5. Conclusion

Our findings suggest that self-directed practice schedules may be in fact suitable for learning complex technical skills. Many clinical skill centers are now offering 24 hour access to their facilities to accommodate the unpredictable schedules of the trainee. However, teaching staff are often not available to provide expert guidance and direction during off hours, thus leaving trainees to manage their own practice sessions. The effectiveness of Self-directed learning and practice should be considered when designing the curriculum for these facilities. If trainees are leaving clinical skill centers with better retention of basic surgical skills, these trainees will be better prepared when entering the operating room. They will also learn more from these hands on patient oriented learning experiences (Gallagher et al., 2005), ultimately resulting in economic savings and in producing better prepared trainees.

Acknowledgments

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